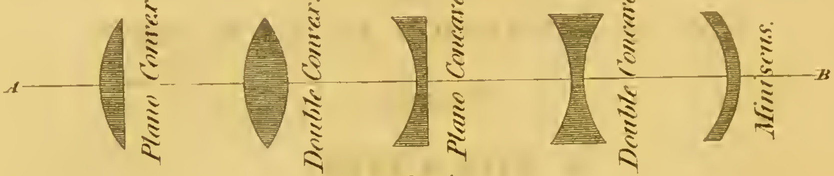
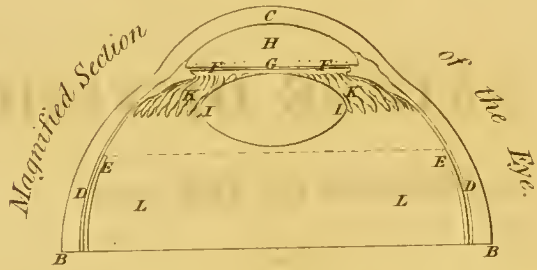
Engraved for Alex.r Alexander's Treatise on Vision.

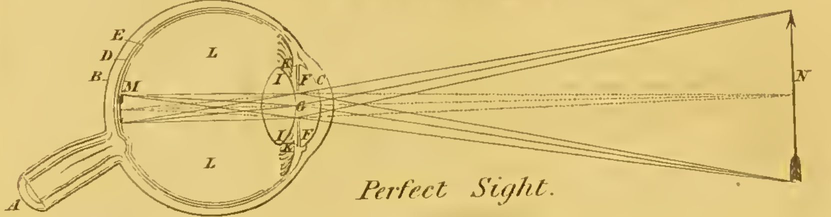
Various forms of Lenses.



A & B. Their axes.



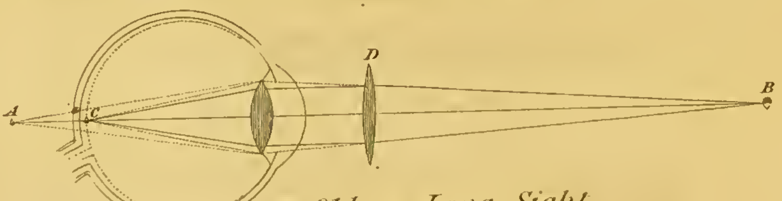
Section of the Eye according to Soemmerring.



Perfect Sight.

A. Optic Nerve. B. Sclerotica. C. Cornea. D. Choroid. E. Retina. F.F. Iris. G. Pupil. H. Aqueous humor. I.I. Crystalline lens. K. Ligamentum ciliare. L.L. Vitreous humor. M. Inverted picture on the Retina of the object N.

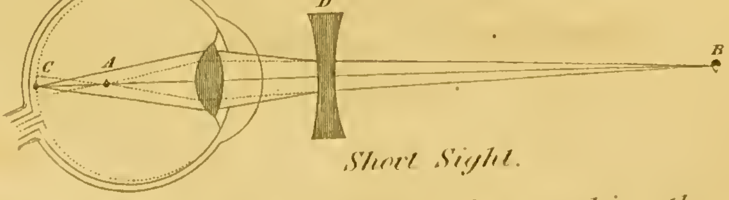
Vide Page 39.



Old or Long Sight.

A. Picture of the object B shown beyond the Retina. C. the picture perfected and brought to a point on the Retina by the Convex lens D.

Vide Page 43.



Short Sight.

A. Picture of the object B. reflected before reaching the Retina. C. the picture brought on the Retina by means of the Concave lens D.

Vide Page 43.

Roper Sc. Exeter

DEDICATED

BY SPECIAL PERMISSION TO HIS MAJESTY.

A TREATISE

ON

THE NATURE OF VISION,

FORMATION OF THE EYE,

AND THE

CAUSES OF IMPERFECT VISION,

WITH

RULES FOR THE APPLICATION OF ARTIFICIAL ASSISTANCE, AND OBSERVATIONS ON THE DANGER ARISING FROM THE USE OF IMPROPER GLASSES.

By ALEXANDER ALEXANDER,

Practical Optician,

AND OPTICIAN IN ORDINARY TO THEIR ROYAL HIGHNESSES THE DUCHESS OF KENT, AND THE PRINCESS VICTORIA.

———" Omnem, quæ nunc obducta tuenti
Mortales hebetat visus tibi, et humida circum
Caligat, nubem eripiam."—*Virg.*

LONDON:

LONGMAN, REES, ORME, BROWN, AND CO.

1833.

EXETER:
PRINTED BY W. C. POLLARD, NORTH-STREET.

TO THE

KING'S MOST EXCELLENT MAJESTY.

Sire,

My pen is inadequate to express the sentiments of gratitude I feel, in having your gracious permission to dedicate to your Majesty this small Treatise, the first production of my humble pen. My motive for coming thus before the public, is to endeavour to prevent the many impositions now practised on your Majesty's liege subjects, by persons pretending to supply Optical assistance, who have not any knowledge of the Anatomy or Physiology of the organ of vision, as thousands have suffered from their sight being seriously injured by such pretenders. With the utmost submission, and deepest sense of duty, I assure my beloved Sovereign, that the distinguished patronage your Majesty has been graciously pleased to bestow on me, shall act as a stimulus to my attaining greater knowledge of my profession, with a view that it may further tend toward the public good.

With the most ardent prayers that your Majesty may live long to sway the sceptre over our blessed Isle, in Health, Peace, and Happiness,

I have the honor to be,
With profound veneration and respect,
Sire,
Your Majesty's faithful
And devoted Subject and Servant,
ALEXANDER ALEXANDER.

6, *High-Street*, *Exeter*,
October 10, 1833.

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PREFACE.

In submitting to an enlightened public, the following pages, the writer of them is not in the remotest degree actuated by any sordid motives, or the desire of becoming an author; his sole aim being to prevent such lamentable and ruinous occurrences to one of the greatest gifts of nature, namely, the organ of vision, as have too frequently come under his immediate observation, arising from the application of improper artificial remedies, to assist impaired nature. In endeavouring to perfect such his intentions, he has avoided, as far as possible, all technical terms, in order to render himself intelligible to those of his readers who may not, as well as

those who *have*, made the science of Optics their study.

Of the diseases of the eye, this work does not treat, although it fully explains the anatomical parts, formed by nature for the purpose of vision, the clear understanding of which, the writer has obtained by anatomizing, as well as studying that organ, under the superintendance of eminent professional men. He is aware that the learned and critical reader will peruse the first publication of a writer, with more than ordinary scrutiny, particularly when he finds him commencing his career with a subject like the present; he will call forth that analyzing acumen, which has so frequently enabled him to detect the errors, and (if his sympathy has kept pace with his mental acquirements) to lament the wanderings of fancied genius; but, whether he assumes the haughty attitude of the censorious, or the milder benignity of the impartial critic, he feels equally tranquil as to the final result. There is however one merit he trusts he may be allowed to claim, that of rendering his meaning,

and the opinions he has laboured to establish, clearly understood; and he apprehends his readers will be at no loss to discover the spirit and tenor of his arguments, having studiously sought to avoid throwing an importance over them, by that studied ambiguity of expression, which affects to dignify style, by perplexing the understanding, and which it would appear was thought by those by whom it is used, as looking most profoundly wise, when made most unintelligible; he therefore feels assured that the shafts of criticism, unless deprived of charitable and manly sentiments, will not be levelled at this, his first endeavour to promote that great end of our existence—"universal good."

INTRODUCTION.

The faculty of seeing, has ever been considered one of the greatest gifts nature has bestowed on mankind; and it may well be said, that the true value of sight can only be fully known by its loss. Its inestimable worth is, however, better appreciated, when we consider the miseries attendant on the want of it; for, among the numerous "ills that flesh is heir to," there are none more justly dreaded, or more deeply felt, than a deprivation of this sense. By its powerful agency, we become acquainted with the works of the Creator; we are enabled to trace His wisdom, His power, and His goodness, in every object that surrounds us; indeed so manifold are its blessings, that the mind of man, though cultivated and expanded by education, is

inadequate to conceive, and his pen to describe, their number. It is, in short, an organ by which all the important effects of light are perceived; an organ not less to be admired for its mechanical properties, than wonderful in its structure. Its appearance, and the numerous contrivances, (if the expression may be allowed,) by which all its motions are performed, excite unutterable astonishment, and clearly point it out as one of the most inimitable works of Divine Wisdom. We are indebted to it for the delightful sensations which arise from viewing and contemplating the proportion and variety of forms, the harmonious mixture of colors, and all the countless beauties of the terrestrial world, ordained for our study or enjoyment.

A TREATISE,

&c.

ON THE NATURE OF VISION.

Vision, or the *faculty of seeing*, is well defined to be a sensation* caused by the impingement of inconceivably fine particles, of a peculiar and imponderous substance, reflected from all luminous bodies, *hence termed rays of light*, and are refracted through the

* When adequate impressions are made upon our organs, we are conscious of sensation. *Perception* is a term used synonymously with *sensation;* but metaphysicians attach different meanings to the words sensation and perception, and use the latter to express the knowledge of the presence and qualities of external objects which follows *upon sensation.*

humours of the eye, upon the retina, (an expansion of the optic nerve, in the posterior portion of the eye, adapted to receive their impulses,) thence conveyed to the *sensorium*, (the organ of sensation in the brain,) from which the mind *perceives* objects, in form, size, color, and distance.

In order to fully comprehend the nature of vision, it is necessary to make some observations on the Nature and Properties of Light, in which the author has been guided by studying the works of the immortal Sir Isaac Newton.

Light has been admitted to be an imponderous substance, emanating from the sun and all other luminous bodies; it consists of a number of particles, of inconceivable minuteness, ejected with immense velocity in all directions, by means of a strong impulsive power, and, from calculation, known to move at the rate of two hundred thousand miles in a second. These particles are emitted in right lines, and are called rays; they continue their rectilineal motion, until influenced by

attraction, which alters their course. That these particles, which constitute light, are very minute, appears from this. If a hole be made in a card with a pin, rays of light from every object on the farther side of it, are capable of being transmitted through it at the same time, without any confusion, for any one of these objects may as clearly be seen through the hole, as if no ray passed from any of the other objects.

It is evident that these particles proceed from every point of the surface of a visible body, and in all directions; for wherever a spectator is placed with regard to the body, every point of that part of the surface turned towards him, is visible, as also that they proceed from the body in right lines, as only those rays will be intercepted in their passage, by an interposed object, as that object will intercept.

Further, if a portion of a beam of light be intercepted by an opaque body, the shadow of that body, will be bounded by right lines

passing from the luminous body, and meeting the lines which terminate at that which is opaque.

The bodies through which rays of light pass, are termed *media*. These media have the power of altering, and modifying, the course of the ray, according to the density, or rarity, of the medium through which the ray passes; this effect is termed refraction.

Thus when a ray of light passes from a denser, into a rarer medium, as from water into air, it is refracted from a line drawn perpendicular to the point of contact; and this refraction will be greater in proportion to the rarity of the fluid, into which it passes. When however a ray passes from a rarer, to a denser medium, as from air into water, a contrary effect ensues,—the ray is drawn or attracted towards the perpendicular, and this in proportion to the density of the medium.

It is necessary to observe, that only those rays which enter another medium obliquely, suffer refraction; a ray which falls perpendicularly, is equally attracted on all sides,

and therefore has no tendency to deviate in any direction.

The line which a ray describes, before it enters a denser, or rarer medium, is called the incident ray; that which it describes after it has entered, is the refracted ray; the angle, formed by the incident ray, and a line perpendicular to the surface on which the ray strikes, is the angle of incidence; and that between the refracted ray and the perpendicular, that of refraction. It was formerly considered that refraction was increased, by giving a peculiar shape to the medium, if solid; but this is not the case, for LENSES *

* Lenses are made of pieces of solid glass, ground to various figures; that is, terminated by various surfaces, and according to their form are termed double-convex, plano-convex, double-concave, plano-concave, and miniscus—a concave surface on one side, and convex on the other. [For their various forms, see sections of them in the plate.] A right line, perpendicular to the two surfaces of a lens, is called the axis, which axis, when both surfaces are spherical, passes through both their centres, but when one surface is plane, it falls perpendicularly upon that, and goes through the centre of the other.

have merely the power of altering the disposition of rays, by causing them to converge, if the lens is convex, or to diverge, if concave.

Having briefly explained the laws of refraction, I shall now treat of those

OF REFLECTION.

When rays of light come in contact with an opaque body, they rebound, or are reflected from its surface. Newton, to designate the action of light, termed reflection, sometimes makes use of the word attraction, and at others repulsion. He does not always confine himself to action at a distance, to explain the effect, which takes place in regard to reflection, and refraction. These effects, he presumes, may depend on the influence of a very subtile matter, every where diffused, even through the interior parts of transparent bodies; and conceiving this matter to be denser in rare bodies, and the density regularly to increase in a small degree, in passing

from a dense to a rare medium. He imagines that on this hypothesis, it may be possible to explain how light is refracted under certain circumstances, by gradually inflecting its motion, and how, under other circumstances, it is reflected by endeavouring to avoid spaces composed of dense matter, to pass through that which is more rare.

When light is reflected on meeting a body that is opaque, the particles of that body appear to exert upon it a repulsive action, and since the body when transparent, acts at the same time by attraction, on the portion of the light that refracts itself, we may conceive this attraction, to extend as far as to a plane situated at a very short distance from the surface of the body, and parallel to that surface, beyond this plane, a repulsion takes place, as far as another distance almost infinitely small.

From the whole that has been written by that great philosopher, on the refrangibility of light, it is at least probable that the reflection

and refraction of light, are produced by particular forces, of the nature of those which are between particle, and particle; and considering the effects simply as they appear to our senses, we may apply the words attraction and repulsion, to those forces, in the same manner as in chemistry, the word affinity is employed to denote the tendency, which the constituent particles of bodies have for each other.

The modifications of light are either transmission, reflection, or refraction, and upon these modifications, the appearance of all surrounding objects depend.*

The next subject in the nature of vision, to be elucidated, is that

* That branch of optics which treats of the reflection of light, is called Catoptrics, from two Greek words, one of which signifies *from* and *against*, and the other to *see*, because objects are *seen* by the light reflected from them. That of refraction is termed Dioptrics, also from two Greek words, the one signifying *through*, and the other to *see*, because the bodies which produce this change, are those through which we can *see*, or through which light *passes*.

OF CHROMATICS,

Which treats of the colors of light, and was but little understood before the illustrious Newton investigated the subject, until which period, light was considered homogeneous. But Sir Isaac discovered that when a solar ray is made to pass through a prism, by means of a hole in a window shutter, and affixing the prism by its axis, it is separated and refracted into rays of different colors, producing (what has been termed) the solar spectrum, an oblong image; these rays possessing different degrees of refrangibility, exhibit *seven* different colors, namely, violet, indigo, blue, green, yellow, orange, and red, blended into each other; the violet, forming one boundary, and the red, the other. These rays, not only differ from each other in their color, but in their illuminating powers, and other circumstances. The greatest illuminating power, is contained in the lightest

yellow, and palest green; the least, in the violet rays. Before I proceed farther on this subject, I am desirous of giving some *general* notions of the form, and effects of the prism, which will not perhaps be thought intrusive.

This instrument is straight and triangular; it is made of white glass, free from bubbles, veins, and other defects; its lateral faces, should be perfectly plane, and of a fine polish. The angle formed by the two faces, one receiving the ray of light that is refracted in the instrument, and the other affording it an issue on its returning into the air, is called *the refracting* or *refringent angle* of the *prism.* A ray of light, penetrating a medium terminated by two parallel faces, assumes, on repassing into the air, a direction parallel to the one it possessed, before it entered the medium. This is not the case when the medium is a prism, whose faces are inclined to each other, for the emergent ray, necessarily makes an angle with the incident ray. We must however except the case where the incident ray,

and the perpendicular at the point of incidence, are in a plane, whose section, with the face on which the ray falls, is parallel to the edge that passes through the summit of the refringent angle. For if we prolong this plane till it meets the face through which the ray issues, its section, with that face, will be parallel to the first section, and as the ray remains on this plane, it follows that it is in the same case here, as if the two faces were parallel to each other, and accordingly it will come out of the prism in a direction parallel to that taken by it at first.

The limits of this work not permitting my being more diffuse in this branch of the science, I shall conclude with the cause of the different colors produced by the refrangibility, transmission, refraction, and reflection, of the solar rays.

The diversity of colors in bodies, proceed, in general, from their particular disposition to reflect light. The body, that reflects every kind of ray in the mixed state in which it

receives them, appears *white* to us ; white, therefore, properly speaking, is the common mixture of all colours. Bodies have the peculiarity to reflect one sort of ray, more abundantly than another, by absorbtion of the other rays that may fall on them ; the body will appear of the colour only, of the species of rays reflected.

A great number of bodies are also fitted to reflect at once, rays of various species. This quality of selection, (as it were,) in bodies, which varies to infinity, occasions the different kinds of rays to unite in every possible manner, and proportion. Hence the inexhaustible variety of shades, which nature has diffused over the surface of different bodies.

When a body absorbs nearly all the light which reaches it, it appears black ; it transmits to the eye so few reflected rays, that it is scarcely perceptible in itself, and its presence, and form, makes no impression upon us, unless as it interrupts, in a manner,

the brightness of the surrounding space. Dr. Herschel discovered that light is also accompanied by rays which excite heat, and that this power was greatest in the red, and least in the violet rays.

The operation of light in producing the phenomena of vision, may be considered under two heads;—the perception of color, and form, depending directly on the rays of light, and the perception of distance, and size of objects, which is attributable to habit, and experience, assisted in many instances by the sense of touch.

I shall now suppose the reader acquainted, in a measure, with the fundamental points or basis of the nature of light; the velocity of its movement; the meaning of the terms used to denote the actions of the rays of light, such as direct, reflected, and refracted; also, the equality between the angle of reflection, and the angle of incidence; and the facts that refraction, is increased according to the

relative density of bodies, and that the convergence of rays after refraction, is proportionate to the curvature of the surface through which they pass. Further, the decomposition of light, by the prism, into seven elementary colors, which differ in their refrangibility; the reflection of all the rays together producing the appearance of white, while their partial reflection occasions the various diversities of color, and their total absorption the sensation of black. Lastly, the emission of the rays of light from every visible point of the surface of a luminous body, and their divergence thence so as to form a cone, of which the apex corresponds to the point from which they emanate, and the base to the surface upon which they impinge.

All which forms the function of the eye, or organ of vision, of which I now purpose giving a description, especially of those parts adapted by nature for the performance of vision.

DESCRIPTION OF THE EYE.

In laying before the reader a comprehensive description of the eye, it will be necessary to explain—first, the external, and then the internal parts, or those more immediately subservient to the purposes of vision. The *globe, or ball of the eye,* is placed in a bony cavity, called the ORBIT. Its form is not exactly spherical, the line forming its visual axis exceeding its transverse diameter. It is composed of certain coats, and tunics, containing three distinct transparent substances, called the humours of the eye, and is furnished with several nerves, and vessels, adapted to their various functions.

The Orbit is of a conical shape; its dimensions are somewhat irregular, composed of several bones, and sufficiently large to allow a free motion of the globe of the eye on all sides, and for the purpose of enclosing the muscles, which move and adapt it to vision

in all directions; the vessels which nourish its membranes, and secrete its humours; the nerves which supply these several parts with energy; and the gland for preparing the lubricating fluid, which is essential to its economy. It also provides for the lodgement of the adipose substance upon which the eye ball rests, and which facilitates its motion.—In addition to the protection the eye receives from the orbit, it is further benefited by the parts which surround it, as the eye-brows, eye-lids, eye-lashes, and lachrymal apparatus.

Those prominent arches of hair, which are termed the eye-brows, protect the eyes from perpendicular rays of light, from a too vivid degree of radiance, and prevent their being incommoded by the perspiration, or any substance that might slide down the forehead, and otherwise fall into the eyes. That the eye-brows may still be more effectually useful, and form a perfect screen, they are furnished with muscles to draw them down and corrugate them; and when walking in a dusty

road, or exposed to a dazzling light, we pull down the eye-brows, thereby shading the eye from the glare, and protecting it from the dust, or other foreign bodies.* The eye-brows may be considered as organs of mental expression, indicating thought, surprise, and danger. The EYE-LIDS, are two semi-oval moveable curtains, which cover the great aperture of the orbit. They protect the eye from light bodies, which are constantly floating in the atmosphere, and by their frequent involuntary closing, offer relief to the retina, by an alternate exclusion and admission of light. They also diffuse, by their motion, a fluid over the eye, (secreted by the lachrymal gland,) which lubricates the surface, and thus more perfectly adapts it, for transmitting the rays of light.†

* Shades which encompass the forehead, and project about three inches from it, are properly adapted to guard weak eyes from a redundancy of light incompatible with the natural strength of the organ of vision, which, from various causes, is much greater in some individuals than in others.

† "The object is not merely to lubricate the surface of

Each eye is furnished with two lids, the one superior, the other inferior, joining at the two extremities, which are called angles. The eye-lids are lined with a membrane, called the conjunctiva, which is reflected over the anterior portion of the eye, and prevents any dust, or other extraneous particles, from getting under the globe of the eye, into the orbit. The edges of the eye-lids are stiffened with a cartilaginous arch, so that they may close with greater exactness, and to prevent their falling into wrinkles, when they are elevated or depressed. The lachrymal gland, is composed of a number of small globular bodies, from which seven or eight ducts, not much thicker than a hair, run into the inner surface of the eye-lid. It secretes the fluid

the eye, or to wash off light bodies which are brought in contact with it, but to spread over its anterior surface, a thin layer of tear, which produces a refractive medium between that of the atmosphere, and the transparent cornea; a theory which is proved by the power of vision becoming imperfect, when the tear is wiped off the globe of the eye."

" *B. B. Cooper's Lectures on Anatomy.*"

called tears. It has been computed, that in twenty-four hours, the two lachrymal glands discharge about four ounces of this fluid. The tears are of a saltish taste, and, when chemically analysed, are found to contain water, mucus, common salt, and a portion of soda, and lime.

The EYE-LASHES, like two palisades of short hair, proceed from these cartilaginous edges, warning the eye of danger, and protecting it from straggling motes; they also intercept many rays, proceeding from objects that are above the axis of vision, and thereby render the images of other objects, more distinct and lively. The hairs of the eye-lashes grow only to a certain length, and never need cutting; they are generally of the same color as the eye-brows; the points of the superior are turned upwards, those of the lower or inferior downwards. From what has been said, it may be perceived why the sight of those, whose eye-lashes are black, is in general much stronger, than those who have

them fair or white; the black eye-lashes are a better shade for the eyes, and reflect no light from their inner side, to weaken and efface the picture on the retina. Montaltus gives an account of a young man, whose eye-lashes, and eye-lids, were, (as he says) "of an *intense* white, and his sight obscure during the day, but clear at night; this person was taken prisoner by the Moors, who died his eye-lashes black, by which his sight was much strengthened; in the course of time, the dye was effaced, and his sight again became weak." Dr. Russell, in his Natural History of Aleppo, says that "it is the custom among the Turkish women, to blacken the margin of their eye-lids, not only as an ornament, but as the means of strengthening their sight." When the eye-lashes are lost, (an effect which frequently follows a malignant small-pox,) the sight is always considerably impaired. By shutting the eye-lids partially, it is found that we can exclude as much light as we please, and thus further defend the eyes

from too strong a light, which, from experience, proves to be as injurious to them, as more gross matter. We have an instance on record, which confirms this truth.—The Carthagenians cut off the eyelids of Regulus, and then exposed him to the bright rays of the sun, which very soon caused blindness. Such facts make it clear that a protuberant eye is not so well calculated for vision, as the one that is deep sunk in the head. Neither extreme is, indeed, of advantage to the possessor, but, of the two, the deep set eye is preferable, as affording the clearest sight, and being the least liable to injuries, from external accidents. The velocity with which the eyelids move, is so great, that it does not at all impede the operation of sight. This curious circumstance may be illustrated, by the well-known phenomenon, of a burning coal appearing like a ring of fire, when whirled round with rapidity, in the circumference of a circle. It is highly probable, that the appearance of the coal, in the several

parts of the circle, remains on the mind, till it returns again to the same place. If, therefore, our eye-lids take no longer time to pass and repass our eyes, than the coal of fire takes to go round, the impression made by any object on the eye, will suffer no sensible interruption, from this motion. The eye is furnished with six muscles, which spread far over it; by these, it can be moved upwards and downwards, to either side, and in every intermediate direction, and thus view surrounding objects, without moving the head. To facilitate these motions, a great quantity of loose fat encompasses the globe of the eye, between it and the orbit. Four of the muscles are straight, and two oblique. They have all their proper and distinct names, according to their situations and offices. The subject of the muscles should not be passed, without some observation of a singular design in the wise disposition of their various functions. The four straight muscles, are intended to move the eye inward, one being above, one below, and

one on each side of the ball. The upper one raises the eye upwards and backwards, the lower draws it downwards and inwards, the outer moves it toward the temple, and the inner pulls it toward the nose. In order to have an oblique motion of the eye towards the nose, a small cartilage is placed, with a hole in it, through which the tendon of the muscle passes, (in the same way as a cord through a pulley,) to a convenient insertion, and thereby gives an oblique motion to the eye. The two oblique muscles draw inwards, and upwards, making the globe of the eye perform a rotary motion, which directs the pupil downwards, and outwards. Many are the advantages derived from our having two eyes; the sight is rendered stronger, and the sphere of vision extended. For, as each eye looks upon the same object,* a more forcible

* Haller affords unexceptionable evidence of the fact, that we employ our eyes severally, and at the same instant, in distinct vision, but the interval is too short to be measureable.

impression is made, and a livelier conception formed, in the imagination. The eyes, together, view an object more distinctly to what they would do separately, and enable us to see small substances, and judge of distance, more accurately, as the impression made on our two eyes, at one and the same time, is represented single to the sensorium.

We find that those who have lost the sight of one eye, are apt to mistake the real distance and position of objects, even within the space of a yard or two. Instances of this kind are principally seen in snuffing a candle, &c. When an object is placed at a moderate distance, we see more of it by means of two eyes, than we possibly could, with one; the right eye, seeing more of the right side, and the left, more of its corresponding side.

Having stated the principal external parts of the eye, I shall now proceed to the *internal*, or those which constitute

THE GLOBE OF THE EYE.

The parts which compose the Globe of the Eye, may be defined, in general, as a kind of case, consisting of several membranes and coats, containing three pellucid humors, which give shape to the eye-ball, and are so adjusted, that the rays proceeding from luminous objects, through the transparency of the cornea, and passing through the pupil, are brought to a focus on the back part of the eye, where they fall upon a soft pulpy substance, from whence the mind receives its intelligence of visible objects. The eye is bounded anteriorly, by the tunica conjunctiva; posteriorly, by the straight and oblique muscles, vessels, nerves, and a quantity of fat; above, and to the outer side, by the lachrymal gland; below, and to the inner side, by the lachrymal passages. It is not to be expected, that any account given of the eye can be strictly accurate, for, as it is

impossible to examine all the parts of the eye, whilst in a natural and living state, so it is also, nearly impossible, when it is dislodged from the socket, to preserve the figure of the parts, entire, a circumstance which I imagine accounts for the difference of opinion we find among anatomists.

OF THE COATS OF THE EYE.

The eye is of a globular form, inclined to protuberance in front, and is composed of three membranes, called coats, and three pellucid substances, as before named, called humors. Each coat and humor has a different name. The first, or outer coat, is called the *Sclerotica;* the second, or middle, the *Choroid;* and the interior one, the *Retina.*

1st.—*Sclerotica* and *Cornea.* The exterior membrane, which encloses and covers the whole eye is called the *Sclerotica* and *Cornea;* it is, however, strictly speaking, but one and

the same membrane, with different names, appropriated to different parts—the hinder, or opaque part, being more generally denominated the *Sclerotica;* the fore, and transparent part, the *Cornea.* The *Sclerotica* is hard and elastic, of a blueish white color; the hinder part is very thick and opaque, its greatest density being in the vicinity of the optic nerve, but it gradually becomes thinner, as it advances towards the fore part of the globe, where the white of the eye terminates; the fore part, is thinner, and transparent; it is also more protuberant and convex, than the rest of the eye, appearing like a segment of a small sphere, applied to a larger, and is called *Cornea,* from its horny appearance. The cornea, is thick, strong, and insensible; is perfectly transparent, and composed of concentric lamellae, connected by a delicate cellular tissue, containing a transparent fluid; it is not perfectly circular, its vertical being less than its transverse axis. Its anterior surface is convex, more or less prominent in different

individuals, and is supposed, by some anatomists, to be covered by the tunica conjunctiva. Its posterior surface is concave, and covered by the serous membrane of the aqueous humor.

2.—*Choroid.* Under the sclerotica is a membrane, known by the name of the *Choroid*, which is a soft, and tender coat, composed of innumerable, minute blood-vessels; it is concentric to the sclerotica, and adheres closely to it by a cellular substance. This membrane is outwardly of a dark brown color, but inwardly of a deeper dye; like the sclerotica, it is distinguished by two appellations—the fore part being called the iris, the hinder retaining its name of choroid. The first-mentioned part commences at the place where the cornea begins; here it attaches itself more strongly to the sclerotica, by a cellular substance, forming a kind of white narrow circular rim, called the ligamentum ciliare. The choroid separates at this place from the

sclerotica, changes its direction, turning, or rather, folding inward, towards the eye, cutting the axis of the eye transversely, and is termed the iris. The iris is a delicate circular membrane, suspended vertically, from the ciliary ligament, and behind the transparent cornea, so as to separate the space between the crystalline lens, and the cornea, into chambers, the anterior of which, is the larger of the two. They communicate with each other, freely, through the central aperture of the iris, which is called the pupil. The iris diminishes in thickness, from its base to the margin of the pupil. The eye is denominated blue, black, &c. according to the color of the iris. The more general colors are the hazel and the blue, and very often both these colors are found in the same eye. It has been observed, that, in general, those whose hair and complexion are light-coloured, have the iris blue, or grey; and, on the contrary, those whose hair and complexion are dark, have the iris of a deep brown. Whether this occasions

any difference, in the sense of vision, I have not discovered. Those eyes, which are called black, prove, when narrowly inspected, to be only of a dark hazel color, appearing black, because they are contrasted with the white of the eye. Black and blue eyes, are considered the most beautiful, and certainly impart a fire and vivacity of expression, far exceeding any other color. Black eyes command more force and impetuosity, but the blue excel in sweetness and delicacy.

The pupil of the eye has no determinate size, being larger or smaller, according to the quantity of light that falls on it. When the light is strong, or the visual object too luminous, the pupil becomes contracted, in order to intercept a part of the light, which would otherwise hurt or dazzle the sense; but when the light is weak, the pupil becomes enlarged, that a greater quantity may enter the eye, and thus make a stronger impression upon the organ of vision. This aperture dilates, also, for viewing distant

objects, and becomes narrower for such as are near. The latitude of contraction and dilation, of the pupil, is very considerable; and it is truly admirable to behold, that, while the pupil changes its magnitude, it preserves its figure. In children, the aperture is more dilated, than in grown persons; in adults, it is still smaller, and has but little motion;—hence it is, that those who begin to require spectacles, are obliged to hold the candle between the eye and the paper they read from, that the strong light may force their rigid pupils into such a state of contraction, as will enable them to see distinctly. Those who are short-sighted, have the pupils of their eyes, in general, very large; whereas, in those whose eyes are perfect, or long-sighted, they are smaller. The whole of the choroid is opaque; by which means, no light is allowed to enter the eye, but what passes through the pupil. To render this opacity more perfect, and the chamber of the eye still darker, the posterior surface of the iris is

covered all over with a black mucus, called the pigmentum nigrum. This pigment is thinnest upon the concave side of the choroid, near the retina, and on the fore side of the iris; but it is thickest on the exterior side of the choroid, and in the posterior of the iris. The circular edge of the choroid, at that part where it falls inward to form the uvea, is stated to be of a different substance from the rest of the membrane, being much harder, more dense, and of a white color.

3rd.—*Retina.* The third and last membrane of the eye, is called the *Retina.* It is spread, like a net, over the bottom of the eye; is the thinnest and least solid of the three coats; is a fine expansion of the medullary part of the optic nerve. It lines the choroid, and covers the surface of the vitreous humor, terminating where the choroid falls inward.*

* Some authors, as Zinn, affirm that it terminates at the ciliary circle; others, as Dr. Haller, represent the whole, or a part of it, as extending to the lens, and even as giving a

It is, in truth, a very essential part of the organ of vision; for on it the images of objects are represented, and their picture formed. The retina is always transparent, and colorless; any apparent changes, therefore, of its color, must depend upon alterations of the pigmentum, which is seen through it. At the end of the eye, and in the very centre of the retina, there is a small hole, with a yellow margin; it is called the foramen centrale, or central hole, though it is not a hole, but merely a transparent spot, free of the soft pulpy matter, of which the retina consists.

Optic Nerve.—Behind all the coats, is situated the *optic nerve,* which passes out of the skull, through a small hole in the bottom of the orbit. It enters the orbit a little inflected; is of a figure somewhat round, but compressed, as it passes into the globe, and continues to the inside of the axis of the eye, towards the nose.

covering to that humor; but, Dr. Monro observes, that it ends some way behind the ciliary circle.

OF THE HUMORS OF THE EYE.

The three transparent substances, inclosed by the coats of the eye, and invested in their respective membranes, are called the *aqueous*, *crystalline*, and *vitreous* humors. These substances, are of such forms and transparency, as not only to transmit readily the rays of light, but also to give them the position best adapted for the purposes of vision. They are clear, like water, and do not tinge it with any particular color.

Aqueous Humor.—The first of these, or *aqueous humor*, is the most fluid of the three, and resembles water, (whence its name,) filling the great interstice between the cornea, and pupil, and also the small space extending from the uvea, to the crystalline lens, called the anterior, and the other, the posterior chambers of the eye; and swelling out the fore part of the eye, into a protuberance very favorable to vision. The iris is suspended in

this fluid; it covers the fore part of the crystalline, and the part which is before the iris; it communicates with that behind, by the opening which forms the pupil of the eye. It is encased in a membrane so tender, that it cannot be made visible, nor preserved, without the assistance of a fluid. The color, and consistence, of this humor, change with age; it becomes thicker, and less transparent, as we advance in years, which is one reason, among others, why many elderly persons do not reap all that benefit from spectacles, which they might perhaps reasonably expect.

Crystalline.—The second humor of the eye, is the *crystalline,* which is as transparent as the purest crystal. Its substance is gelatinous, and of much denser consistency at the centre, than near the surface, for the purpose of correcting its spherical aberration. Its form is that of a double convex lens, of unequal convexities, the most convex part being received into a corresponding concavity, in the vitreous humor; it is often termed the crystalline lens,

from its form. The crystalline is contained in a kind of case, or capsule; the fore part of which, is very thick and elastic, the hinder, thinner and softer. The capsule is suspended, in part, by a structure, called ligamentum ciliare; which, together with the crystalline, divides the globe of the eye, into two unequal portions. The lens is formed of concentric plates or scales, succeeding each other; the scales are formed of fibres, so as to constitute a tender cellular texture.* Between each is a pellucid liquor, which, in old age, becomes of a yellow color. The innermost scales lie close together, and form a sort of nucleus, harder than the rest of the lens. The yellow color, where-

* It has been disputed by some, that the crystalline is not composed of fibres; but I have examined the crystalline of a sheep, and by exhibiting it to a clear light, the grooves and fibres are easily distinguished. The author of a well written treatise on cataract, in describing the species of capsular, or membraneous cataract, says, it exhibits the natural structure of the crystalline, demonstrates the seat of the disease, "*the existence of the original arrangements of its fibres,*" and the healthy and transparent state of the capsular.

with the crystalline is more tinged, must, as we advance in years, make objects also partake of the same shade. Nor does the fact of our being insensible of any change in the color of the objects, prove to us that the color remains the same; for, in order that we should be sensible of this change, the tincture must not only be considerable, but must change on a sudden.

Vitreous Humor.—The *vitreous,* is the third humor of the eye, deriving its name from its appearance, which is like that of melted glass. It greatly resembles the aqueous humor, and is contained in a proper capsule, termed the hyaloid membrane, formed of a series of cells, which give it a firm appearance. It is by far the largest of all the humors; and supports the globular shape of the eye, extending from the insertion of the optic nerve, and filling the whole space to the crystalline lens, which is imbeded in its fore part. It supports the retina, and keeps it at a proper distance for

receiving and forming distinctly the images of objects.

The foregoing description, it is hoped, will be sufficient to give a general idea of the construction and formation of the parts of this wonderful organ, *formed for the purposes of vision.*

OF VISION.

By holding a convex lens opposite a window, so that the rays passing through it, are reflected, showing the image of the window frame, on a sheet of white paper, placed against a wall opposite, clearly illustrates vision, as obtained by our organs of sight. Vision, so far as our eyes are concerned, consists in nothing, but such a refraction of the rays of light, by the transparent humors of the eye, as will form a distinct picture of the object upon the retina; for the structure of the eye plainly indicates, that, in order to obtain perfect vision, it is necessary

that a certain number of rays, from every visible point of an object, should be united at the posterior of the eye, and that the points of union of the rays, of the different objects, should be as distinct and separate as possible. The eye is admirably contrived for adapting these purposes; all the rays coming from any visible point of an object, that can enter the pupil, are united closely together upon the retina, and thereby make a more powerful, and much stronger impression, than a single ray can do.* To answer this purpose, the retina is placed at a proper distance behind the refracting substances, and each pencil of rays is refracted regularly into separate and distinct foci, falling upon the most sensible parts of the optic nerve, that the whole object may be distinctly seen at the same instant, which would not be the case otherwise, as the rays from different objects, or from different parts of the same object, would strike at the same place at once, and thus create

* See figure in the plate.

indistinctness, nearly equal to blindness. In proportion to the intensity of light, the pupil enlarges and contracts itself, for the admission of more or fewer rays, that the impression on the retina, may be rendered suitable to the respective cases. As the crystalline humor is most dense in the middle, it is therefore probable, that it is not equally refractive. This difference in density, of the constituent parts of the crystalline, is admirably contrived for correcting the aberration from its figure, as well as that from the cornea. The more remote rays of each pencil, by passing through a medium, gradually diminishing in density, from the middle towards the extremes, have their foci gradually lengthened, which corrects the aberration of the figure, so that they may unite closer together. The concave figure of the retina is somewhat serviceable for the same purpose. It is by no means easy to determine, with accuracy, the measure of refraction of the different humors of the eye; but from such experiments as

could be made, it has been found that the refractive powers of the aqueous and vitreous humors, are much the same as common water, and that of the crystalline, a little greater.*

* The following are the dimensions of the Eye, as given by Dr. Young and M. Petit.

	Eng. In.
Length of the optical axes - - - -	0.91
Vertical chord of the cornea - - - -	0.45
Versed sine of ditto - - - - -	0.11
Horizontal chord of ditto - - - -	0.47
Opening of the pupil seen through ditto - 0.27 to	0.13
Diminished by magnifying power of cornea to 0.25 to	0.12
Radius of the anterior surface of the crystalline lens - - - - - - -	0.30
Radius of the posterior surface - -	0.22
Principal focal distance of the lens - -	1.73
Distance of the centre of the optic nerve from the central hole at the end of the axis -	0.11
Distance of the iris from the cornea - -	0.11
Distance of the iris from the anterior surface of the crystalline - - - - -	0.92
Range of the eye, or diameter of the field of vision - - - - - - -	1.100

Dr. Brewster and Dr. Gordon took the following measures of the crystalline and the cornea from the eye of a woman above fifty years of age, a few hours after death.

Diameter of the crystalline - - -	0.378
Diameter of the cornea - - - -	0.400
Thickness of the crystalline - - -	0.172
Thickness of the cornea - - - -	0.042

The humors of the eye, altogether, form a kind of compound lens, whose effects, in refracting rays, have a given focus of coincidence.

If the humors of the eye, by age or any other cause, shrink and decay, or the cornea or crystalline be too convex, the rays, in the first case, unite beyond the retina: in the latter they converge before their arrival at the retina, and the image thereon is, of course,

The following are the refractive powers of the humors of the eye, according to different observers :—

	Aqueous Humor.	Crystalline Lens, Outer Coat.	Centre.	Mean.	Vitreous Humors.
Hauksbee	1.33595	-	-	-	1.33595
Jurin -	1.3333				
Rochon -	1.329	-	-	-	1.332
Young -	1.3333				
Brewster	1.3366	1.3767	1.3990	1.3839	1.3194

From the last of these measures, the following indexes of refraction may be deduced :—

For rays passing from the aqueous humor into the outer coat of the crystalline lens - - 1.9466

For rays passing from the aqueous humor into the crystalline, taking its mean index of refraction - - - - - - - 1.0353

For rays passing from the outer coat of the crystalline into the vitreous humor - - 0.93

indistinct. These defects, as will be shown hereafter, may be remedied by the use of glasses. The latter defect is to be relieved by the application of concave glasses, equal to the too great protuberance of the cornea, and refractive power of the humors; so that the rays are made to diverge, thereby causing them to meet, immediately, on the retina. In the former, of a due convexity, in proportion to the loss of convexity in the eye, by its humors flattening, or losing their refractive power.*

OF THE EXTENT OR LIMITS OF VISION.

Having considered the general principles of vision, I shall now proceed to explain the nature, properties, and extent, or power, of the eye. As in a dark chamber, a very slender beam of light is visible, so, in all cases when the surrounding medium is very dark, objects are seen by small quantities of light—

* See figures in the plate.

consequently, when the medium round the eye is dark, a small quantity of light will suffice for vision, the eye being, by the exclusion of adventitious light, rendered sensible to the most delicate impression. The extent, therefore, of our sight, is increased, or diminished, in proportion to the quantity of light that surrounds us, supposing the illumination of the object, to remain the same.* Thus, in a dark night, the feeble light of a candle may be seen at a great distance; the fixed stars, though they have no sensible diameter, are visible; and the darker the night, the more of them are seen. A certain quantity of light, is, however, necessary, even in this case, for vision; for the impression of light, from the satellites of Jupiter and Saturn, are too feeble to be perceived, unless with the assistance of a telescope. When a beam of light is let into a darkened room, small particles are seen

* It is here neeessary to observe, that a middling size oval aperture, for glasses of speetacles, is far preferable to the use of large round glasses.

floating, but as soon as the room is impartially lighted, the particles disappear.

OF DISTINCT AND INDISTINCT VISION.

It will be proper, in this place, to explain what is meant by *distinct vision*, and what is the difference between seeing an object *distinctly*, and seeing it *clearly*; as the clearness, or brightness, with which an object is seen, is often confounded with distinct vision.

We see an object *clearly*, when it is sufficiently illuminated to enable us to form a general idea of its figure, and distinguish it from other objects; we see it *distinctly*, when we can point out the parts of it, and determine their color and situation. Thus, we may be said to see a distant object *clearly*, when we can pronounce that it is a building; but, to see it *distinctly*, we approach so near as to be able to *determine*, not only its general outline, but to distinguish the parts of which it is composed. The brightness, or clearness,

with which an object is seen, depends principally on the following circumstances:—

1st—On the quantity of light proceeding from the object, to the eye; and this is in a great measure regulated by the distance, the intensity of light diminishing in an inverse ratio, to the square of the distances.

2nd—It depends on the color of the object, and of those objects which surround it.

3rd—On the manner in which the light falls upon the object, and is reflected from it.

4th—On the aperture of the pupil; for the wider this is, the greater will be the number of rays that are transmitted to the retina.

5th—On the transparency, and purity, of the humors of the eye, and the soundness of the rest of the parts necessary to vision.

6th—On the transparency of the atmosphere.

When all these circumstances concur, an object will appear bright and clear; but less, in proportion as any of them are wanting. In order, however, to obtain distinct vision, it is

requisite not only that the object be sufficiently illuminated, but also that the several pencils, on their arrival at the retina, should be separated, and not mixed together; when this is not the case, the outlines of the object, and its parts, will appear faint, hazy, and ill-defined. We may therefore consider the following conditions as necessary towards obtaining distinct vision:—

1st—The object should be sufficiently illuminated. All other circumstances being the same, the nearer an object is, and the brighter its color, the more light the eye receives from it. This is one reason why near objects are more distinctly seen, than those that are more remote.

2nd—The geometrical image of objects should fall either on the retina, or very near it; and these images should be sufficiently large, otherwise the parts of the objects cannot be distinctly perceived. The want of size in this image is also the cause of the indistinctness of remote objects.

3rd—It is also requisite that the eye be unimpaired, and its humors transparent, in order that the impressions of light may be lively and distinct. When an object is at some determinate distance, that distance agreeing with the focal length of the refractive parts of the eye, the image on the retina will be most perfect; it is near this point, or place, that objects, if they are not too small, will be distinctly seen. An object at a greater or less distance, will have its image either before or behind the retina; and in either case, if the distance of the image from the retina, be considerable, the vision will be indistinct. Hold a printed page, in which there are letters of three or four different sizes, at such a distance, that every sort of print may, without any straining or effort of the eye, be perfectly distinct—in this case, it may be reasonably presumed that the images of the several letters fall upon the retina. If the printed leaf be brought nearer by degrees, the smallest print will first begin to be con-

fused, whilst the larger remains as distinct as before. By drawing it still nearer, the smaller print will become more confused, the next size above it less so, whilst the largest is still as legible as before; and so through several degrees, till the whole is chaos.

The nearest distance of distinct vision, is in general computed to be about seven or eight inches from the eye. The point, in any object, to which the optic axis is directed, is seen more distinctly than the rest. The truth of this position, is confirmed by every one's experience. If we turn our eyes directly towards one particular part of an object, so as to look steadily at it, we may, if the object be not very large, see all the rest of it, at the same time; but this part will appear more distinct than the rest. Looking steadily at an object, is turning our optic axis towards it.

ADJUSTMENT OF THE EYE FOR DISTINCT VISION, AT DIFFERENT DISTANCES.

It must be evident to all persons who consider the subject, that the rays of light which issue from an object, at some distance from the eye, and those issuing from a much nearer object, cannot be collected into foci at the same given distance behind the crystalline lens, unless the eye have a power of altering its focal distance. It must do for itself, what a convex glass does for those, who, by reason of a certain configuration, cannot see near objects distinctly. Or a concave glass, for those who have not distinct vision, beyond a moderate distance. In the first, it is owing to a want of refractive power, the rays not being brought to a focus soon enough; in the second, owing to too great a refractive power, and thereby brought to a focus too soon.

It has been shown by eminent writers on optics, that if an object be viewed distinctly

at three different distances from the eye, the first of which, may be the least distance, at which it can be viewed distinctly, the second, double the first, and the third, infinite; the alterations in the conformation of the eye, necessary for viewing an object distinctly, at the first and second distances, whose difference is but small, are as great as those that are necessary for the second and third, whose difference is infinite. For instance—a short-sighted person can read small print distinctly, at two different distances, if the greater distance is but double the lesser; similar changes being applicable to his eyes, as to those which are perfect, and can see distinctly also at all intermediate distances, between infinity and the greatest of the two former distances. For the same reason, a short-sighted person can see distinctly at *all* distances, with a concave lens, of a proper figure; for the cause of near-sightedness, is not a want of power to vary the conformation of the eye, but that the whole

quantity of refraction is too great for the distance of the retina from the cornea. From this we may also clearly perceive, why our eyes are so often fatigued in looking at near objects; for in this case, the muscles of the eyes, are obliged to make a considerable effort, to give them the necessary conformation; which effort being greater in proportion as the object is nearer, must be painful and laborious when the object is very near. When the eye has been attentively fixed on an object at some determined distance, it cannot immediately see another object distinctly, whether it be at a greater or lesser distance, for it will appear confused and imperfect, till the eye has adapted itself to the distance at which the object is placed.

MOTION OF THE IRIS, AND EFFECT OF LIGHT ON THE PUPIL.

In speaking of the structure of the eye, it has been shown that the iris has a small

round aperture, nearly in the middle, called the pupil, through which the rays must pass, before they can get to the bottom of the eye, and paint images of objects on the retina. The considerations of the various affections of this part of the eye will be found of great importance, to the purchaser of spectacles; for upon the state and aperture of the pupil, the requisite degree of the magnifying power depends. The magnitude of the pupil is proportioned, so that it may answer the purposes of vision, and the sensibility of the retina. If it were too large, the retina would be fatigued and injured by the immense power of light—from whence it may be infered, that those creatures cannot bear the light of day, who, in order to search for, and procure their food at night, have the pupil of their eyes very large. If this aperture had been much larger than it really is, the eye would not have been a dark cell, and so much adventitious light would have entered, as to have rendered the picture upon the

retina obscure and indistinct; for, as in the Camera Obscura, the pictures are most lively and perfect when all the light is excluded, except what is derived from the object, and serves to form the picture; so it is with our eyes—the picture upon the retina is most perfect, when all the extraneous light is excluded. On the contrary, if the pupil had been very small, it could not have admitted a sufficient quantity of light; and consequently, the impression on the retina must have been weak, and the picture more faint and obscure. When the pupil is very small, convex glasses are necessary, in order to increase the quantity of light. When the light is too strong, or the object too bright, the pupil *becomes* contracted, so as to intercept the light, which would injure the eye; but when the light is weak, it becomes so dilated, as to admit a greater quantity of light entering the eye. That the motions of the iris, which take place upon the sudden changes of light, are involuntary, there is no doubt; for even in sleep, when the

will is not exerted, it can be observed, by opening and closing the lids. If a person looks towards the sun, the pupil will contract; but if he turns his eyes from the light, and is gradually brought into a darker place, the pupil will dilate as the light becomes more faint and indistinct. There are also other circumstances which will cause the pupil to contract—such as when the object is nearer the eye than the limits of distinct vision. In this case, the pencil of rays are too diverging to be united in corresponding points on the retina; but, by the pupil contracting, many rays are excluded, and the picture is rendered more distinct. It is from this cause, many short-sighted persons contract a habit of corrugating their eyebrows, in reading, which might be prevented by the use of concave spectacles.* Let any person take a book by day-light, and stand near the middle of a

* Dr. Jurin has shown that the contracting of the pupil in general, more depends on the strength of light, than on the sensation of confounding objects.

room, with his back to the light, and hold the book so near that the letters may appear indistinct—not so much but that they may be read, though with difficulty—on turning towards the light, it would be read with more ease. Again—hold the book at the same distance, and go to the darkest part of the room, standing with your back to the light, and you will find the letters not at all legible; but, on coming to the window, with your face to the light, you will be able to read with ease and facility. I have known a person, who had been accustomed to use spectacles for some years, enabled, in the sunshine, to read without them. When the eye has been accustomed to a strong light for some time, or in viewing resplendent objects, and immediately looks on objects that are less so, the sight will, for a short time, be impaired, and the eye unable to perform its proper functions. The like effect will also result from the contrary circumstance; of going from a faint light, to one that is resplendent, in either case

the pupil has not time to conform itself to the transition under the new circumstance; but, the pupil is never so contracted, as in the case of passing suddenly from a faint, to a bright light—the contraction being instantaneous. What has therefore been said on the contraction and dilation of the pupil, leads me to state that *very opaque* shades, round a candle, instead of preserving and protecting the eye, must be absolutely prejudicial to it. A moderate degree of opacity in the shade, (as that of oiled paper,) may, by lessening the degree of light, be useful to eyes that are inflamed, or have a tendency to inflammation.*

There is a kind of sympathy, or concord, in the motion of the pupils of both eyes, so

* Persons habituating themselves to read, or work, at night, where there is a strong light, or attending public assemblies; or persons being in the habit of walking in open grounds, or travelling in open carriages, where the reflection of the sun is powerful; or even, also, in winter, when the ground is covered with snow, should have coloured glasses, of selected tints, (according to the state of the sensibility of the retina) free of veins, or small threads, mounted in dark frames, which would preserve and protect their eyes.

that when one contracts, the other contracts; when one is dilated, the other also dilates, though neither the contraction or dilation may be equal. From this expanding and contracting power of the eye, we may conceive why the eyes see best when surrounded by darkness; and therefore objects are seen most clearly, when the pupil is most dilated. When the eye is in the dark, the picture is neither confused nor disturbed by adventitious rays. Hence, those who are in a very bright light, and want to distinguish accurately, a distant object, either depress the eyebrows, or apply the hand to the forehead, acting as a kind of shade. A person placing himself in the dark, and employing a long tube, will form a species of telescope, producing a very different effect from what might at first be perceived. It was on this principle that the ancients used a deep pit, in order to see the planets in the day-time. We hereby also learn, why a person from within a chamber, can perceive the objects that are without, whilst those that are out of doors,

cannot see them that are within—for when we are out of doors, the pupil is contracted, and only a small portion of the light that is reflected from the objects within the chamber, can pass to the retina ; while, on the contrary, those within, have the pupil more dilated, and the objects that are without, are more strongly illuminated. Besides which, their view of objects, is not so much obstructed by the reflection of the window glass.

It is astonishing how far the eye can accommodate itself to darkness. When first taken from the light, and brought into a dark room, all things disappear ; or, if any thing be seen, it is only the remaining radiations, or impression, that continues on the mind ; but after a very short time, the eye takes advantage of the smallest ray, which is confirmed by the following curious account related by Mr. Boyle.

" In the reign of Charles the Tenth, a man had been confined in a dark and dismal dungeon, into which the light never entered ; there being no opening but a hole at the

top, through which the keeper put his provisions, always closing it after him. The unfortunate man had been confined some weeks in this dungeon, when he began to think he saw some glimmering of light. From time to time it so increased, that he could not only discover the parts of his bed, and such other large objects, but at length could perceive the mice that frequented his dungeon to eat the crumbs which fell upon the ground. When set at liberty, he could not, for some days, venture to leave his cell, lest the brightness of the light should blind him. He was therefore obliged to accustom his eyes, by slow and gradual degrees, to the light of day."

OF IMPERFECT SIGHT.

There is no branch of science of which it is more important that a general knowledge should be diffused, than that which treats of the various imperfections of sight, and the remedies for the same. Those coruscations of

human art which enlarge the powers of vision, are, in preference to all others, justly entitled to the praises of mankind. The invention of optical instruments is therefore to be esteemed as one of the most useful gifts the Supreme Artist has conferred on man. Admirable as the eye came out of the hands of Him who formed it, yet no part of the animal frame is so susceptible of changes, from length of years, or decline of *health;* nor is any organ oftener injured by accident, or affected by disease. But to counteract those defects, or the consequences of accidents, it is happily permitted that no organ can be so much assisted by human contrivance, as the eye—not only in promoting the real uses and comforts of life, but for the advancement of a most essential branch of science.

I shall now explain what is meant by an an imperfection of sight.

The sight is relatively imperfect, when we cannot see an object distinctly, in a common light, and at all the usual distances, at which

it is observed by the eye, in a perfect state. In this sense, both the long, and the short-sighted, are said to have an imperfect sight. The short-sighted, see distant objects confusedly; those that are near at hand, distinctly —their sight is therefore defective, with respect to the former. On the other hand, the long-sighted, see distant objects distinctly, and near ones confusedly. An imperfect sight, is occasioned by a confusion in the image formed upon the retina. This happens whenever all the rays, proceeding from any single point of an object, are not united again in one, but fall on different parts of the retina; or, whenever several pencils of light, from different points of the one object, terminate upon one point of the image. This species of confusion takes place both in long and short-sighted eyes.

OF OLD, OR LONG-SIGHTED EYES.

"To detail those circumstances, which are, in general, marks of advancing age, and

always of partial infirmity, must be ever unpleasant, and would be equally unnecessary, if it were not the means of lessening the inconveniencies naturally attendant on the closing scenes of our pilgrimage."—*Adams on Vision.*

By the long-sighted, remote objects are seen distinctly, near ones imperfectly; and in proportion as the defect increases, the nearer objects become more indistinct, till at length it is found almost impossible to read a common size print without assistance. An imperfect and confused image is formed upon the retina, because the rays of light, that come from the several points of an object, at an ordinary distance, are not sufficiently refracted, and therefore do not meet upon the retina. The causes which in a measure occasion this defect, is the convexity of the cornea being lessened, or either side of the crystalline becoming flatter, or the retina being too near the cornea or crystalline, it will give rise to the same defect, as will also a

less refractive power in the pellucid parts of the eye. In the like manner, too great a proximity of the objects will prevent the rays from uniting on the retina; but if all these causes occur together, the effect is greater. This defect, however, is commonly attributed to a shrinking of the humors of the eye, which causes the cornea, or crystalline, to lose their original convexity, and to become flatter; and the same cause will bring the retina too near the cornea. By one or other of these causes, those who were accustomed in their youth to read a common size print at the distance of twelve or fourteen inches from their eyes, are obliged to remove the book two or three feet before they can see the letters distinctly, and read with comfort; but, in proportion as the object is removed from the eye, the image on the retina becomes smaller, and consequently small objects will not always be perceivable at that distance to which persons in this state find it necessary to remove them, in order to attain any degree of

distinct vision. The further also the object is removed, the less light will enter the eye, and the image will, of course, be fainter. Therefore, those who are long-sighted, require more light, to enable them to read, than those whose eyes are in a perfect state, because the pupils are smaller, and consequently, a greater quantity of light is necessary, to produce a sufficient impression on the retina, and compensate for this defect, by a greater splendour, and illumination of the object. Increasing years have certainly a tendency to produce this defect, and it often occurs early, among those who may have made great use of their eyes, in their youth. But whatever care be taken of the sight, the decay of nature cannot be prevented ; the humors of the eye will gradually waste and decay, the refractive coats will become flatter, and the other parts of the eye more rigid, and less pliable. Thus the latitude of distinct vision will become contracted, and it is also highly probable that the retina and optic nerve lose a portion of

their sensibility. Though it is in the almost unvaried course of nature, that this defect should increase with age, yet there are many instances of those, who have recovered their sight at an advanced period, and been enabled to lay aside their glasses, and read and write independent of artificial assistance. Among many causes, which may produce this effect, the most probable is, that it arises from a decay of the fat at the bottom of the orbit; the pressure on this part ceasing, the eye expands into somewhat like an oval form, and the retina is removed to a due focal distance from the crystalline. It is a certain and very important fact, that long-sightedness may be the effect of habit; for those who are accustomed to look at remote objects, are generally long-sighted, want spectacles sooner, and use the highest magnifiers. On the other hand, the greater number of short-sighted persons are found among students, and such artists as are daily required to look on small and contiguous objects.

The miniature painter and engraver see very near objects better than a mariner, but the latter has the advantage in distant ones—the eye, in both cases, labouring, as it were, to preserve that configuration with which it is most familiar. In the organ of sight, as well as in the other parts of the body, the muscles, by constant exercise, are enabled to act with more ease and power, but are enfeebled by disuse. The elastic parts, also, if they are kept too long stretched, diminish in their elasticity; while, on the other hand, if they be seldom exercised, they grow stiff, and are not easily distended.*

Reverting to these facts, we may learn, in

* On this principle I protest (and from actual experience) against the use of the single eye glass; for, as it is generally used only to one eye, the eye which is not allowed its regular action, loses its refractive powers, and becomes of little or no service. I would recommend those who require assistance, and do not wish, or feel a dislike at all times to put on their spectacles, (which is certainly very inconvenient) to adopt the use of the *double* eye glass, or hand frame; which article I am happy to say, (for the sake of those who require its aid) is become a prominent ornament in dress.

a great measure, how to preserve the eyes; and also, by habituating them occasionally to near as well as distant objects, we may enjoy their services longer in their perfect state, and be enabled to *postpone* the use of spectacles for many years. But we may also infer, from the same premises, that there is great danger, when the eyes are become long-sighted, of deferring too long the use of spectacles, or using those that magnify too much, as we may, by either method, so flatten the eye, as to lose entirely the benefit of naked vision. It may not be improper, in this place, to remark, that the long-sighted eye is much more liable to be injured by too great a degree of light, than that which is short-sighted; which proves the necessity of applying for artificial aid only to such persons as are well qualified to supply glasses of the proper focal number. Too many have suffered materially by purchasing glasses without consulting a person sufficiently experienced in the science of optics. Objects that appear

confused to long-sighted persons, will be rendered more distinct, if they view them through a small hole, such as that made by a pin in a card, because it excludes those diverging rays which are the cause of confusion, and at the same time it intercepts a considerable portion of the light. The best relief that can be obtained, is from convex glasses; for by these, the rays of light which proceed from an object, are so refracted, as to fall upon the retina in the same manner as if they issued from a distinct point. Spectacles afford two advantages—they not only render the images of the objects distinct upon the retina, but they also make it strong and lively.

OF THE SHORT-SIGHTED.

In this defect of the eye, the images of objects at an ordinary distance, unite before they arrive at the retina, and consequently those formed thereon, are confused and indistinct. This effect is produced either by a

convexity too great in the cornea and crystal line, or a redundant refractive power in the humors of the eye. In another view of the case, the retina may be placed too far, or it may arise from a concurrence of all these circumstances. Those who are short-sighted, can distinguish minute objects with the assistance of less light than others. The reason is very obvious; for the nearer the object is, the more light enters the pupil. Being also more dense, the action is more powerful on the retina, and the image depicted longer—hence the short-sighted can read a small print in a weak light, when others not so afflicted, can scarcely distinguish one letter from another. In a strong light, short-sighted persons can see a little further than they do in a weak one, because the strength of the light causes the pupils of their eyes to contract, and thus remove, in some degree, the obscurity of the objects. Upon the same principle, we may account for the short-sighted so often partially closing their eye-lids.

Happily for them, the chief inconveniences of their sight, can be remedied by the use of concave glasses. By their assistance, those whose sphere of distinct vision scarcely extends beyond the length of their arm, are enabled to discern satisfactorily, objects at a considerable distance. The concave lens produces distinct vision by causing the rays to diverge more, and unite at the retina, instead of meeting before they reach the bottom of the eye.

In the choice of glasses for the short-sighted, no accurate rule can be laid down; it is a defect that has no connexion with age, or stated progression, that can be a foundation to guide the optician in recommending one glass in preference to another. The whole depends on the experience of the short-sighted themselves, who, by trying glasses of different degrees of concavity, will soon discover which are the most advantageous—yet in this case, as well as in the case of the long-sighted, much depends on the spherical and pellucid qualities of the glasses, and the skill of the optician,

in fitting them in frames, so that they may be truly parallel before the eyes.

The benefit which short-sighted persons receive from concave glasses, is not equal to that which the long-sighted feel from a convex lens; for an object is not only magnified, but the eye receives also a larger pencil of light, from each visible point, because the rays enter less divergingly—whereas the concave not only diminishes the object in size, but lessens also the quantity of light, as it renders the object more diverging. Consequently, the short-sighted do not see remote objects, unless they are very large and bright, so well through a concave lens, as theory promises; for the chief impediment to a distinct view of remote objects, is their want of light and magnitude—but both of these are increased by a convex lens.

It is generally supposed, and is the opinion of some eminent writers, that the short-sighted become less so, as they advance in years, from the natural decay of the humors of the eye

lessening its convexity; but among the great number the writer has supplied with glasses, he has found the reverse of this theory to be true, by their applying to him frequently for deeper concaves after some time, to see as well at the same distance as when they first commenced the use of glasses. This he considers the effects of habit, which are in most cases very powerful, but peculiarly so in the affections of the eye, from its having a natural tendency to short-sightedness.

Watchmakers, engravers, and studious persons, prove this by more frequently evincing the defect alluded to. As children, in general, read much nearer than grown persons, they will, if suffered to indulge in this propensity, become habitually short-sighted. This defect is more frequently known among the rich than the poor, owing, in a great measure, to their habit of study. When children are studying, they should be placed in high chairs, to prevent their eyes coming too close to the book.

THE ASSISTANCE THE EYE REQUIRES AFTER THE OPERATION FOR CATARACT.

The writer has stated in his preface, that this work will not, in any shape, treat on the *diseases of the eye*, (not being the province of an Optician,) but as some of his readers may not be perfectly acquainted with the disease called Cataract, he will briefly explain the state of the organ, in this instance.

The seat of this disease, is in the lens, (or crystalline humor) which in its incipient state presents a slight opacity; and at last the lens appears as a thick, white or greyish colored substance, the opacity gradually increasing, until it becomes so general, as scarcely to admit of any rays of light entering the posterior chamber of the eye, and consequently the image of any object cannot be formed. Though the retina, and other parts of the organ, are in a perfect state, the opacity of the lens is sometimes so great, as to prevent per-

sons seeing more than the distinguishing of light from darkness. The only remedy is the hand of the operator; and from the diffusion of anatomical knowledge, and skill in the practical operations in surgery, in this country, our professional men are blessed with happy results in this, as well as other operations. The assistance the eye receives from the surgeon, is either by depression of the crystalline below the pupil, by dividing the lens into small parts, which are afterwards absorbed; or by total extraction, according to the species of disease. The defect in the organ, after operation, is caused by the loss of the lens, one of the most refractive of its optical powers, the vacancy caused by its removal being filled with aqueous fluid. The eye therefore cannot see any object distinctly, unless the loss be supplied by an artificial lens, in the shape of spectacles; two pair of these are generally required, one for near, and the other for distant objects—the eye having lost its power of adjusting itself to different

distances. The foci generally used, are from one inch and a quarter, to five inches and three quarters. It is not advisable to use glasses too soon after the operation; instances have been known, in which the early exertions of the eye, thus assisted, has been prejudicial.

OF SPECTACLES.

"Were there no other use of optics, than the invention of spectacles, for the help of defective eyes, I should think the advantage mankind receives thereby, inferior to no other benefit whatever, not absolutely necessary to support."—*Molyneaux's Optics.*

"Spectacles restore and preserve to us one of the most noble and valuable of our senses. They enable the mechanic to continue his labours, and earn a subsistence by the work of his hands, to extreme old age. By their aid, the scholar pursues his studies, and recreates his mind with intellectual pleasures;

and thus pass away days and nights with delight, which might otherwise have been doomed to melancholy, or wasted in idleness."—*Kitchener on the Use of Spectacles.*

As spectacles are designed to remedy the defects of sight, it is natural that the materials for their construction, should be selected as perfect as possible, and that great care and attention be observed in manufacturing them, particularly as it respects their convex and concave surfaces corresponding in all parts. If the dangers and inconveniences arising from the use of common spectacle glasses, manufactured by wholesale, from all sorts of defective materials—oft times even from common window glass—passed off on the public by the various puffings of the day—such as being manufactured by *chemical and other processes;* sympathetic pebbles, which, as the sight alters, will accommodate themselves to the sight, and by which "one pair will last the wearer for life"—and other pretended improvements of these enlightened times, the

advertisements for which are generally headed with arms of foreign nobility—if these things were seriously reflected on by the public, the experienced and skilled optician would not have occasion to repeat so often to poor creatures who have been led away by such absurdities, and who apply to him for assistance, that it is out of his power to render it, the eye having become actually morbid, by the use of defective glasses. So much also for " bargain hunters," (as Dr. Kitchener says) who, under the idea of saving their pockets, make cheap purchases, as they imagine, of *Pedlars, Toy shops, Sale shops, Pawnbrokers,* and others; persons who *do not profess* to have any knowledge of the proper focal number, requisite to remedy the defect; and in which case oftentimes a number of spectacles are laid before the purchaser, for the purpose of their selecting what may suit them, and who generally choose glasses much too powerful, elated at the idea of seeing objects *very large,* considering they are admirably adapted for them; but that seem-

ing advantage continues only for a short time, and greatly injures their organs of vision. It must be clearly seen, that looking through glasses of various powers, the focal distance being so frequently altered, must irritate the eye to such a degree, that a proper selection must be difficult. When, on the contrary, the skilled optician is applied to, he asks questions, to gain the necessary information, if the eye be affected by disease, or a natural decay, or from over exertion, he will supply glasses of a convexity, agreeing with the flatness of the eye, or the state of the diseased organ, which will both preserve and assist it. The fact should not be omitted, that *double the price is charged, upon an average,* by those persons, than that for which the article can be procured at a respectable establishment.

A few points may be adduced, showing the bad effects arising from the use of common glasses, in the hope that no false notions of cheapness or economy, will in future prevail with even the poorest, to have recourse to them,

as they utterly destroy the sight they were expected to assist and preserve. It is, indeed, a matter of serious import to the poor; and great praise is due to the benevolent persons (among them the writer has the pleasure to know several ladies of this city and its vicinity) who are forming a society for the purpose of distributing *good spectacles* to such as are in absolute want of them, and have not the means of purchasing. The result of this must be highly beneficial, and it is hoped the plan will be universally supported.

Such an establishment will not interfere with the benevolent practice of oculists who gratuitously relieve the poor, nor with charitable institutions for removing diseases of the eye, but tend much to prevent the necessity of surgical or medical assistance.

The grounds of complaint respecting the common spectacles in general are, that their assortment of the lenses is irregular, one of the glasses frequently having a different focus from the other; that they are badly polished,

which affects their transparency; that the two glasses, or lenses, are not of an equal thickness, and are often full of specks and imperfections, which, being partly ground *down*, are not easily observable; and, finally, that the convexity, or concavity, is not regular, the sides not only varying, but different degrees of convexity being absolutely on the same side of the lens.

One great cause of all these evils, is in the mode by which common glasses are *ground*, which is now done frequently by machinery. Every optician must admit, that from the great care and attention required, no lens can be perfect, that is so manufactured.

It is a well received principle with opticians, that the utmost attention of the workman ought to be paid, to the preservation of a regular sphericity in each lens, whether convex or concave; for which reason, each must be kept perpendicular to the plane of the tool—which cannot be done, if several are ground at one and the same time. In

clothing, it is of little importance to health, whether the materials are fine or coarse, but sight can only be preserved by the use of good glasses.

The common glasses having different degrees of convexity or concavity, never represent objects correctly, or of their natural color; but they appear crooked, and tinged with refractive rays along their outlines, which produces in the eyes a kind of attraction, or drawing forward, the oblique muscles being thus obliged to lengthen, in order to see the object distinctly.

This irregularity of foci, in common glasses, frequently goes to such extent, as sometimes to have a focal distance of twelve inches at the centre, and only ten at the circumference; besides which, it is often fitted with another lens, in a frame, whose central focus will differ from that of its exterior, in a directly opposite manner to the former lens. From this it is easy to imagine what injury must be done to the eyes, when thus obliged to change the diameter of the

pupil every instant. These defective glasses mostly produce sparkling or prismatic rays, in consequence of the rays of light being irregularly broken, and passing through various angles. I have also heard persons say, that sometimes they see objects double, or more than one of the same form, which is owing to the various surfaces, each receiving a portion of light from the object, and refracting it in a peculiar direction, so as to give rise to the impression on the mind, that there are as many objects as there are surfaces. The color of these defective glasses, is generally of a muddy green; the way to detect this, is, by laying them on a sheet of white paper; and to examine if they are free from veins, is either to hold them to a bright light, or before a candle.

I shall now take an opportunity of stating my opinion on the use of lenses, ground from *crystal*, known by the appellation of *pebbles*. Though their price is more than double that of the glass, I think their general utility more

than adequate to their additional cost; they are certainly cooler to the eye, more free from veins than glass, are not so easily scratched by general use, and being harder, are capable of receiving a higher polish, by which means their imperfections are sooner discovered.

Having been requested to explain the cause of spots, so frequently seen in the field of vision, and which has been stated to be spots and callosities on the cornea, or crystalline, arising from the use of imperfect lenses, but that not being the case, in my opinion, and considering it to arise from partial pressure on the retina, I, in support of my own opinion, state that of Mr. F. Tyrrell, kindly given to me on the subject. "The grey or dark spots, technically termed muscæ, (musca, a fly,) so frequently appearing in the field of vision, result from partial pressure upon the retina, either from distension of blood-vessels, or from deposition of some new matter in consequence of inflammatory action. Hence they are common to persons suffering

from irregular circulation, in connection with disordered stomach, when they are usually grey, and moving; but those persons, who, by excessive use of the organs, upon minute objects, induce congestion, or inflammation of the choroid tunic, are particularly liable to them, when they are dark. Extensive observation has satisfied me, that any changes in the humors of the eye, or of the cornea, do not cause such appearances." These congested vessels prevent portions of the rays of light from falling upon the retina, whilst other rays mark the image of the object thus apparently spotted with dark points; and at the same time, the rapid motion of the axis of the eye, produces an appearance of numberless quick moving objects.

On this subject, much has been written by De la Hire, a French optician, who observed, that "when a candle, situated beyond the limits of distinct vision, is viewed through a very narrow chink in a card, a considerable

number of candles (sometimes as many as six) will be seen along the chink. This he supposes to arise from small irregularities in the surface of the humors of the eye, the effect of which is not sensible, when rays are admitted through the whole extent of the pupil, and consequently, one principal image effaces a number of smaller ones; whereas, in this case, each of them is formed separately, and no one of them is so considerable as to prevent the others from being perceived at the same time. The same philosopher, in endeavouring to explain the cause of the dark spots before alluded to, remarks, that they were most visible, when the eyes were turned towards an uniform white object, such as the snow in the open fields. If the spots appeared fixed, while the eye was at rest, he supposed them to be occasioned by extravasated blood upon the retina; but when they were moveable, he considered them as proceeding from opaque matter, floating in the aqueous

humor of the eye, supposing that the vitreous humor was not sufficiently limpid for that purpose.

THE RULES FOR THE CHOICE OF SPECTACLES.

"Timely assistance will ease the eyes, and in some degree, check their tendency to grow flatter; whereas, if they be not assisted in time, the flatness will be considerably increased, and the eyes be weakened by the efforts they are compelled to exert. All delay is dangerous; and the longer those who feel the want of assistance defer the use of spectacles, the more they will increase the failure of the eye."—*Adams on Vision.*

"There are many, who find the effect of candle-light so different from the pure light of day, that they are obliged to use spectacles by night, though they can do very well without them, by day. These, when the eye has become more flat, will be obliged to have

two pair of spectacles, one for the day, the other appropriated for night. By these means, nearly the same quantity of light may be brought to act upon the retina, at one time as the other; and thus the eyes will be less fatigued, and longer maintain their natural vigour."—*Dr. Kitchener.*

Having already named that large round spectacles should not be used, it is here necessary to explain. When the eyes are not directed near the centre of the spectacle glasses, the obliquity of their surface to their rays, will be increased, so as to occasion a confused appearance; a great portion of the confusion is removed in the spectacles now usually made, when compared with those formerly employed, whose size being very large, augmented their imperfections; as it will be perceived that when objects are seen through spectacle glasses, no more of the glass is employed at one view, than a portion equal to the size of the pupil of the eye, which upon an average may be reckoned at an eighth of

an inch in diameter. Thus we see how small a portion is used for the purpose of vision; but as it would be tedious to the eyes to be continually looking through a small aperture, the glasses are of a moderate size, and admit of a sufficient degree of motion; and as we require a greater latitude horizontally than vertically, their figure is made of an oval form.

The most general, and perhaps the best rule that can be laid down to those who are in want of assistance from glasses, in order to know when spectacles should be used, and to be enabled to select such as will remedy the defects of vision, is to prefer those which show objects nearest their natural state, neither enlarged or diminished, and at the same distance, and with the same ease, as he could see before his eyes were impaired, and give a blackness and distinctness to the letters of a book, neither straining the eye, nor causing any material exertion of the pupil; for no spectacles can be said to be properly accommodated to the eye, which do not produce

ease and utility. If they fatigue the eyes, we may immediately conclude, either that there is no occasion for them, that they are ill made, or "*not proportioned to the sight.*"

Though, in the choice of spectacles, every one must *finally* determine for himself which are those through which he obtains the most distinct vision, yet great confidence should be placed on the judgment of the artist of whom they are purchased, and particular attention paid to his directions. Many persons have an objection to wear spectacles, as being an evidence of age and infirmity. This objection must be allowed to be absurd, when the distance they are compelled to hold small objects, is a sufficient indication of the decay of vision, independent of the great injury sustained by straining the eyes; some will use a reading glass, or what is frequently termed an eye glass, which they habitually put up to one and the same eye, leaving the other to wander. After a short time, the idle eye acquires a different focus from that which has been

employed with the glass, and is often irreparably impaired. This system hastens the evil it is meant to conceal. Opticians have daily experience of the truth of this. The eye accustomed to see with a reading glass, becomes fatigued, and much strained. There is also another objection to the use of a single eye glass, which arises from the unsteadiness of the hand causing a perpetual motion of the glass, and the eye endeavouring to conform itself to each change. This tender organ is thereby kept in continual agitation, which so much weakens it, that those who continue to use a reading glass, are in a short time *compelled to have spectacles* of much stronger power than they would otherwise have had occasion for.

Whatever care be taken, and though every precaution be observed with scrupulous exactness, yet, as we advance in years, the powers of our frames gradually decay,—an effect which is generally first perceived in the organs of vision.

But age is by no means an absolute criterion

by which we can decide upon the sight, nor will it prove the necessity of wearing spectacles; for on the one hand, there are many whose sight is preserved, in all its vigour, to an advanced period of life; while on the other, it may be impaired in youth by a variety of causes, or be vitiated by internal maladies. Nor is the defect alike in different persons of the same age, or in the same persons at different ages. In some, the failure is natural; in others, it is acquired. No just estimate can ever be formed as an absolute criterion, either of the want, or for the change of, spectacle glasses. Several youths, under the age of twenty, have applied to me, who could not see to read or write without a glass of seven or eight-inch focus; whilst I have met with others, at the age of eighty, who could see without any glass.—I must therefore notice the absurdity of persons pretending to do their friends a kindness, by giving them their spectacles, without first ascertaining if the focal number is adapted to their sight. From

whatever causes the decay may arise, an attentive consideration of the following rules, will enable every one to judge for themselves, when the sight may be assisted or preserved by the use of spectacles.

1st—When we are obliged to remove small objects to a considerable distance from the eye, in order to see them distinctly.

2nd—We may consider the symptoms as indicative, if, from an impulse to which we are not accustomed, we approach nearer to the light when we read or work.

3rd—If, on looking at, and attentively considering a near object, it becomes confused, and appears to have a kind of mist before it, or such as the letters of a book running one in another, or, as it were, becoming double or triple.

4th—If the eyes, after a slight tension, become so much fatigued, that we are obliged to turn them to other objects, in order to get ease.

As soon as these signs show themselves, no

time should be lost in procuring good glasses; but those which are bad, or, which is the same thing, not agreeable to the wants of the eye, will always do more harm than good to that tender organ.

Innumerable opportunities for observation have afforded me so much experience, that I feel it my duty to the afflicted, to point out, in the strongest and plainest terms, the dangers arising from the use of improper lenses, as well with regard to foci, as to their various other imperfections.

The form of the frame of spectacles need also some attention, as very frequently the inconveniences that arise from their improper shape, are imputed to the lenses. It is, therefore, necessary to select such frames as are light, and best fit the form of the head, so that they may rest steady and parallel before the eyes, and not cause any pressure on the temples or on the nose; the former occasions severe pains in the head, the latter what is commonly called a watering in the eye.

REMARKS ON A LATE INVENTION OF AMBER SPECTACLES.

Since this work was handed to the printer, my attention has been called to the newly invented Amber Spectacles, for which a patent has been granted. But although I should at all times be most happy to encourage and assist in promoting *improvement* of any sort, in the construction of instruments for benefitting, or gratifying the sight, yet I must candidly acknowledge I feel myself here bound to make some few remarks on the above invention. Being unable at present to discover any benefit * that can possibly result from its adoption, and as neither the Inventor or Patentees have pointed out the superiority, or shown the advantages of this discovery, I shall offer the following objections, which appear to present

* The Patentees have not mentioned any advantages which spectacles possess, made with Amber lenses; we are therefore *unable* to point out the merits, if any, of this invention. *Repertory of Patent Invention,* Oct. 1832.

themselves to me. First—Amber, being of so soft a nature, spherical truth cannot be depended on in working it; as the manner of preparing it for the tool, will easily convince those who are in any way acquainted with the mode of grinding lenses. Being of such a soft, horny nature, the only way of getting it to the form required, is by filing to nearly the proposed figure, and much care must be taken in so working it to the tool, that the part which has been worked true, is not destroyed in endeavouring to gain the corresponding figure. When pieces of glass are to be ground to the form of a lens, they are warmed by the fire, and fixed to a small block of cement, for the purpose of holding them to the tool; but I am informed by a workman who has been employed in preparing the amber, this must not be done with that article, as it would warp by the slow heat of a common fire. The polish is obtained by using putty powder, or soft soap, and spirits of wine, which polish is very far inferior to that gained upon glass or pebble, and

prevents the discovery of any imperfections, such as veins and specks, so detrimental in lenses used to remedy imperfect vision. I have seen an amber lens that had been in use a very short time, and its polish, surface, and even the *parabola*, had altogether been destroyed by the heat of the body, caused by carrying it in the pocket; I also found it scratch from the mere rubbing of the hand.

Secondly,—the nature of amber is much too warm, the greatest heat being known to exist in the deepest red, and brightest yellow, and the least in the violet or blue. Where it is necessary to assist the organ of vision, and render the sight perfectly easy by a colored glass, that glass should be selected of a color corresponding in a measure with the surrounding objects, that the eye may not be irritated by *heterogeneous* light. From many years experience as an optician, I have found, in supplying persons with colored glasses to relieve their sight, that those who have been in the habit of living in the country, and whose occupation was chiefly in meadows or gardens, have pre-

ferred green, and those residing in towns, blue, corresponding in color with surrounding objects.

I would at all times recommend blue or violet, in preference to any other color, from the facts that light is well known to be composed of particles, and that rays comprised of a less quantity of particles, are easier of refraction. It is evident that red rays are the strongest, and take longer time in passing through a medium, because the particles they contain are not so easily transmitted. On the contrary, violet rays are the finest in substance, contain less quantity of particles, and are more quickly refracted; from which it is clearly conceived, that the images of objects, by rays passing through a medium of violet, or blue, are finer depicted, and quicker transmitted to the retina, than through a medium of yellow, or any other color, and hence vision rendered more perfect. The effect of the yellow upon eyes that are inclined to weakness, must be highly injurious.

In support of my opinion of the amber lenses, I shall adduce that of Mr. Dollond,

which is as follows:—"Mr. D. considers amber a very improper material for spectacles, on account of its color, its not being homogeneous, its liability to scratch, and its being also *impossible* to form it into a perfect lens."

I must not omit also to state, that the price of the amber lenses are more than *three times* that of the best *pebbles*; and from what has been stated, it will be seen that the amber lens must be changed at least every *two* or *three months*, to have them in a perfect state.

After these explanatory reasons, I trust that those who wish to preserve their sight, whilst a good lens of glass or pebble can be procured, will not have recourse to amber.

The writer of the foregoing treatise, now most respectfully takes leave of the reader who has favored his humble production with a perusal.

As stated in his preface, he has not attempted a flowery style of composition, or endeavoured to add complexity to a subject, which the uninformed, even in its plainest

garb, will always find it difficult to comprehend with that precision calculated to produce satisfactory results.

Although the work contains some matter already before the public, and which comprised many volumes, yet in condensing that matter into this small space, nothing valuable on the subject has been omitted. Of entire extracts, he has had the pleasure of specifying the source; of those which have been assimilated to his views by alterations, or taken in a detached or limited manner, where the information was of general notoriety, or its origin uncertain, acknowledgment became superfluous or impracticable.

If, in the course of his labor, (for no book can be written, nor work performed, without due application,) he has been guided by any prevailing impulse, it has been that of endeavouring to *simplify* a science, the vast importance of which, should be brought home to the conviction of all who have not devoted a portion of their time to the study of the many useful sciences.

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